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Draft Curriculum for Wales 2022: April 2019

DRAFT STATUTORY GUIDANCE
AREA OF LEARNING AND EXPERIENCE

Science and Technology

CONTENTS

INTRODUCTION TO THE SCIENCE AND TECHNOLOGY AREA OF LEARNING AND EXPERIENCE

Science and Technology draws on the disciplines of biology, chemistry, computer science, design and technology, and physics to enhance our knowledge and understanding of the world.

Developments in both Science and Technology have always been drivers of change in society, underpinning innovation and impacting on everyone's lives, materially, economically and culturally. As such, this area of learning and experience will be consistently relevant in the opportunities young people encounter and the life choices that they make.

The importance of scientific and technological literacy in our modern world cannot be understated. It is not sufficient that learners can simply 'do' Science and Technology. Ready access to vast amounts of information requires all learners to be able to assess inputs critically, understand the basis of information presented as fact, and make informed judgements that impact their own behaviours and values. They need to develop the ability to meaningfully ask the question, 'Just because we can, does that mean we should?'.

A transformational curriculum

The White Paper *Our National Mission: A Transformational Curriculum*[1] set out the detailed legislative proposals for Curriculum for Wales 2022.

The proposal is that funded non-maintained settings and schools will be required to provide a broad and balanced curriculum that meets the four purposes of the curriculum, and comprises the six areas of learning and experience. There will be statutory duties to teach Welsh, English, religious education, relationships and sexuality education, and the three cross-curricular responsibilities of literacy, numeracy and digital competence. Further information on how the Science and Technology Area of Learning and Experience can support this is provided in the 'Developing a broad and balanced curriculum' section of this document.

Funded non-maintained settings and schools will have discretion as to how they design their school-level curriculum to meet their curriculum duties. However, in considering the exercise of that discretion, they must have regard to statutory guidance issued by Welsh Ministers. In practice, that means they should follow the statutory guidance unless they have good reason not to.

This statutory guidance for the Science and Technology Area of Learning and Experience, which forms part of the wider Curriculum for Wales 2022 statutory guidance, is intended to provide a national framework that funded non-maintained settings and schools can build on to develop their own curriculum. It is not intended to be a comprehensive or exhaustive syllabus, nor a guide for organising timetables. It sets out:

- what funded non-maintained settings and schools should take into account in designing their curriculum and how it could be structured
- the broad expectations for learners for the Science and Technology Area of Learning and Experience at each progression step.

[1] beta.gov.wales/our-national-mission-transformational-curriculum

How the area of learning and experience supports the four purposes of the curriculum

Science and Technology uses prediction, testing and questioning to develop theories and innovations that increase our understanding of both our physical and digital worlds and that aim to improve our lives.

Ambitious, capable learners, ready to learn throughout their lives understand that if repeatable observations, prototypes or experimental results do not support an idea, the idea should be rejected or modified and tested again. Learners who are **enterprising, creative contributors, ready to play a full part in life and work** embrace such challenges, as they are encouraged to take risks, to innovate and evaluate, and learn to develop solutions. Thus, they can become more resilient and purposeful learners across all areas of learning and experience.

Through robust and consistent evaluation of scientific and technological evidence, learners are then supported to become **ethical, informed citizens of Wales and the world**, who will be able to make informed decisions about future actions. **Healthy, confident individuals, ready to lead fulfilling lives as valued members of society** are also informed by knowledge of their bodies and the ecosystems around them, and of how technological innovations can support improvements in health and lifestyle. Indeed it is hoped that the knowledge and deep understanding gained through experiencing What Matters in Science and Technology will help them live independent and fulfilling lives that see them contributing to society in a variety of ways.

WHAT MATTERS STATEMENTS FOR SCIENCE AND TECHNOLOGY

Being curious and searching for answers helps further our understanding of the natural world and helps society progress.

Curiosity about Science and Technology leads us to ask questions about the world around us. Using logic, imagination and creativity, we can apply scientific knowledge to further our understanding of how that world works. We can develop and test useful models to help us make sense of its complexity. With evidence derived from observations new theories can be developed, and existing ideas may be refined or challenged.

We need to be able to evaluate scientific claims to help us make informed decisions that affect our world and well-being. The choices we make depend on many factors, including our moral viewpoints and personal beliefs. However, rigorous and robust evidence-based research provides us with a solid foundation on which to base our decisions. As ethically informed citizens we need to consider the impact of our actions and technological developments on Wales and the wider world, asking ‘Just because we can, does that mean we should?’.

Design thinking and engineering are technical and creative endeavours intended to meet society’s needs and wants.

In Science and Technology, learners use experiences and apply their skills and knowledge to design and shape innovative engineered solutions. As part of a user-centred design process, we develop ideas, manage and mitigate risks, and minimise complexities. When we engineer products, services and systems, we need to understand and control the interactions between materials, components, structures and users. The application of engineering processes allows learners to develop accuracy, precision, dexterity and craftsmanship. By designing and engineering outcomes in response to needs, wants or difficulties, learners become enterprising problem-solvers who are well placed to contribute to society.

The world around us is full of living things which depend on each other for survival.

In Science and Technology, we recognise that living things are diverse, interacting with their environment and evolving over generations. All living things require specific conditions and resources to survive and they may have to compete with other organisms to do so. Humans form part of the living world and our decisions and actions, along with natural selection, can have a significant impact on the diversity of life. Knowing about the structures and functions of living things enables us to understand how they grow, develop and reproduce successfully. Developing an understanding of harmful factors in our environment allows us to make informed decisions, including about seeking prevention and treatments for diseases.

Understanding the atomic nature of matter and how it shapes the world.

In Science and Technology, understanding matter and its properties enables us to recognise the role that chemistry plays in the world around us. Similarly, being able to separate, identify and manipulate substances helps us to better understand both what our world and our bodies are made of. As we then develop a deeper understanding of matter and its properties, we can design and create new substances and materials that can enrich our lives. This activity is particularly relevant in Wales, where it has had significant industrial application and where innovation continues.

Forces and energy determine the structure and dynamics of the universe.

In Science and Technology, forces and energy can be used to describe the behaviour of everything from the smallest building blocks of matter to the motion of stars and planets. Understanding forces and energy helps us to predict and control the behaviour of our surroundings. These ideas can be modelled and expressed formally, providing a consistent mathematical framework to describe physical systems. This has enabled some of society's greatest scientific breakthroughs and engineering achievements. As responsible citizens of Wales and the world, an understanding of forces and energy will help us overcome future challenges and use our planet's resources efficiently.

Computation applies algorithms to data in order to solve real-world problems.

In Science and Technology, we recognise that computational processes have changed the way people interact with one another and their environment, as well as how humans organise their work, their communities, and their lives. Society, in turn, has influenced the development of computation as people's needs for processing information have changed. Through these computational processes, the world has been enriched and technological development has accelerated, and seems set to continue doing so. In order to use and create these technologies to their full potential, learners need to know how they work. Developing creative algorithmic and computational approaches can solve challenging real-world problems. However, we must be conscious that there are limits to what computers can achieve. Understanding that there are also wider legal, social and ethical consequences of how technology is used enables learners to make informed decisions about the application of computational technologies.

Relationships between what matters statements in Science and Technology

The six what matters statements capture the key aspects of learning for Science and Technology. They are designed to operate together, and support settings and schools to develop a more detailed and holistic curriculum for learning and teaching.

What matters statements within this area of learning and experience do not align exactly with traditional subject areas. However, aspects of the traditional Science and Technology subjects can be identified throughout. What also comes to the fore are the links between these aspects of what matters in Science and Technology. For example, the discovery of new knowledge, as well as validation of existing knowledge using scientific and technological reasoning, connects what matters statements throughout the area of learning and experience. Similarly, energy is a core concept across all the disciplines.

The first of the six what matters statements for Science and Technology embraces using evidence derived in different ways in order to question ideas, form opinions and deepen scientific and technological understanding, while also highlighting the impact of Science and Technology. The design and engineering what matters statement champions the technical and creative experiences, skills and knowledge needed to design and shape engineered solutions. Living things and the study of organisms and how they compete to survive is central to the third aspect of this area of learning and experience. The fourth then urges learners to discover more about the nature of matter, and what things are made of, and how they behave and interact. The relationship between forces and energy and how it impacts on us is set out in the fifth what matters. The final statement introduces a new curriculum focus, one which addresses how computation can be applied to solve problems across Science and Technology.

Progression within this area of learning and experience

Learner progression in Science and Technology is developed through experiencing and building knowledge in a range of related ideas, concepts and principles, while embedding practical and wider skills to define a problem, explore ideas, produce solutions and justify choices. The 'Principles of progression' used in the development of achievement outcomes in this area of learning and experience are contained within the 'Learning' section under each what matters statement.

Starting from a more immediate sense of the world, learners develop the ability to consider others and the wider world. Learners move from describing ideas to being able to explain them, and their analysis and description move from qualitative to quantitative. In their progression, learners begin by recognising single factors before developing the ability to consider multiple factors. Their development of simple skills through imitation and manipulation matures into more elaborate skills that enable perfecting and articulating.

While progression in this area of learning and experience is similar across the disciplines, there are key differences between how a learner might progress in the sciences as opposed to design. Progression for most of the area of learning and experience may be represented through either the physical or the intellectual. However, for design and engineering this is not necessarily the case, as the outcome will most often be physical. Thinking often moves from concrete ideas to an abstract understanding within science and computation, while in design and engineering learners can progress from more abstract ideas to concrete outputs.

Developing a broad and balanced curriculum

Literacy, numeracy and digital competence

The cross-curricular responsibilities of literacy, numeracy and digital competence support almost all learning and are essential for learners to be able to participate successfully and confidently in the modern world.

Literacy

Science and Technology provides learners with a wide range of opportunities to develop their literacy skills. Learners need every opportunity to explain their thinking, explore and discuss ideas, and use their literacy skills appropriately in order to communicate their ideas. They will describe and justify their understanding with increasing complexity.

Oracy, whether as group discussions or debates, will support learners' writing and give them a voice into their writing, particularly where they are challenged by difficult concepts. They need opportunities to 'think aloud'; listening, discussing and exploring ideas with each other.

Science and Technology is rich in specialised words, many of which have both everyday as well as technical definitions. Improving learners' spelling, range of technical vocabulary and understanding of the origin of terms, improves their understanding of Science and Technology. Using specialised vocabulary will also develop both writing and a range of reading techniques, such as close reading, skimming and scanning, through access to a range of specialised texts which will deepen understanding and stimulate active discussions.

Numeracy

Learners can reinforce their numeracy skills and apply mathematical knowledge within Science and Technology in a variety of ways. Science and Technology offers opportunities for learners to engage in a wide range of collaborative investigative tasks. Both within and beyond the classroom they can learn to design, create, measure, interpret data, make deductions and draw conclusions, based on evidence.

Learners can work quantitatively, gathering data by making observations and taking measurements. Working independently, and in collaboration, they will design and create prototypes and engineering products with accuracy and precision.

Learners should have the opportunities to develop and refine their numeracy as they process data using calculation, tabulation and graphing skills to research and develop their ideas. The development of these skills will allow learners to make judgments about the accuracy of data with increasing maturity. Learners develop further by changing information from text to data and vice versa, e.g. through interpreting information presented in tables and graphs to identify patterns and describe trends.

Digital competence

Science and Technology gives learners an abundance of opportunities to develop and apply digital skills appropriately. It is important to recognise, however, that this area of learning and experience is not the sole home of digital competence, nor the only opportunity to develop these skills.

Learners should critically evaluate the science and technology they use and develop so that they are prepared to encounter the positive and negative aspects of being a digital citizen. For example, as they source information and understand how to store data appropriately on different systems, they will become more mindful of the implications of data laws. They should also explore methods of electronic communication and identify which are the most effective for given situations.

As learners work, both independently and collaboratively, they should access opportunities to participate in the iterative process of planning, creating, evaluating and improving digital content. Inquiry, problem-solving and thinking skills can all be developed, allowing learners to understand problems with increasing complexity and, importantly, when to use technology appropriately to solve them.

Learners will combine multimedia components in increasingly complex ways, requiring greater consideration of the audience and the purpose of digital content. Learners should have opportunities to gain an understanding of the importance of data and information literacy by exploring aspects of collection, representation and analysis associated with data handling and modelling.

Welsh dimension and international perspective

Learners should explore how Wales' geography, resources and workforce shaped the scientific activity and technological industry of the country, and how it could influence our future society, culture and economy.

Learning about the histories of people with ties to Wales who have contributed to our understanding of the world and key technological advancements is valuable. Celebration of Welsh individuals who currently work successfully in science and technology will inspire learners in an accessible and relevant manner. Equally valuable are the contributions of people from a range of nationalities who work in science and technology in Wales.

The contexts provided by Welsh industry should be used to bring learning to life across the area of learning and experience. Welsh industrial facilities, both traditional and contemporary, involve a wealth of interdependent scientific and technological aspects which can be used to provide powerful reinforcement of learning in a Welsh context. Wales benefits from, and contributes to, international science and technology projects, providing the expertise and skills required to help make these collaborations a success.

Our environmental impact transcends geographical and political boundaries. The effects of industrial activities on Wales' ecology and the effects of Wales' activities on ecosystems in other countries should be a focus, where appropriate.

Wider skills

Through Science and Technology all learners can develop and apply all the wider skills to become more accomplished, resilient and independent learners. As a result, they will become capable and deal more effectively with the opportunities and challenges they face as individuals and members of society, both now and in the future.

Critical thinking and problem-solving

Critical thinking and problem-solving are at the heart of Science and Technology when analysing problems to develop models, solutions and innovations. It helps learners to develop a deeper

understanding of the concepts and competencies required to progress. Science and Technology provides rich contexts for learners to engage in making reasoned judgements, decisions and conclusions, and to develop their ideas, including in the field of computation. Learners will be able to develop their problem-solving skills and personal resilience by learning through failure and feedback from others. Learners will develop their self-evaluation through the critical-thinking processes.

Planning and organisation

Planning and organisation are key in scientific and technological processes. Learners will be able to organise and plan their own projects and ideas, while setting their own goals within distinct requirements. They will be able to critically evaluate their progress and results to further improve their ideas and outcomes.

Creativity and innovation

Curiosity and inquisitiveness develop creativity and innovation; learners should explore and develop ideas and put them into action. Creative thinking is defined as the thinking that enables learners to apply their imagination to generating ideas, designs, questions and hypotheses, experimenting with alternatives, and evaluating their own and their peers' ideas, final products and processes. These areas are essential to problem-solving and effective design.

Personal effectiveness

Science and Technology enables learners to reflect on their own understanding of the world around them. Through this they can form clear, strong values which inform achievable life goals, and enable them to develop as effective citizens. Reflecting on scientific and technological processes can develop personal effectiveness, evaluation of strengths and areas for development, better solutions to problems, and the creation of new innovations.

Careers and work-related experiences

Learning from careers and labour market information

This is a key area for Science and Technology as it is essential for learners to develop an understanding of the real world and contexts for possible employment, as well as life skills. Employers' need for science and technology-based knowledge and skills remains strong.

Science and technology are crucial to Wales' success. Knowledge-intensive organisations and highly skilled people make a major contribution towards innovation, economic growth and the quality of our public services. While related occupations are generally well paid and rewarding, many experience significant ongoing skills shortages and are unable to find suitable candidates to fill vacancies.

Linking the area of learning and experience to careers and work-related experiences

Learners should be encouraged to undertake research and explore the links between Science and Technology and their related career paths. Both science and technology equip learners with the necessary skills and knowledge to pursue careers related to these disciplines. More importantly, the transferable skills which sit at the heart of scientific and technological understanding contribute to learners' preparation for professions and jobs that do not yet exist.

The skills developed through Science and Technology are transferable, highly valued and sought after in the wider employment market. These include problem-solving, interpreting data

and information, reasoning ability and the ability to think logically. While there isn't a 'typical' science and technology job, traditional stereotypes persist and need to be challenged. Females, those with disabilities and those from minority or socially disadvantaged groups are consistently under-represented. With the introduction of careers-related education in primary schools these sorts of stereotypes can be tackled from an early age – an age when they are often formed. A more diverse workforce with rounded scientific and technological understanding is not just desirable in terms of equality, but essential to maximising opportunities for all learners and meeting Wales' economic needs.

Learner progression relating to careers and work-related experiences is part of a continuum of learning for learners aged 3 to 16. Success for a young primary school learner could include:

- acting a variety of different jobs through role play
- belief that they can do any job – tackling gender stereotyping
- communicating with people in their community about the different jobs they do and the rewards that a job can bring.

By progressing learning, success for 16-year-old learners could include:

- demonstrating and applying the skills learned in relation to the world of work
- identifying interests, strengths and skills to make informed post-16 choices
- understanding and demonstrating the behaviours an employer looks for in a good employee
- evaluating risks when developing a business idea and exploring different methods of setting up and sustaining an enterprise.

Work-related experiences

Learners develop interests, strengths, knowledge, skills and aspirations through their educational experiences within and beyond school. A range of partners support these exciting journeys through co-design and co-delivery and together they shape learners' decisions about their future and the pathways they follow. Opportunities such as visits, guest speakers and practical activities can help to enhance and contextualise learning.

Collaboration and access to individuals and employers provide learners with opportunities to learn about work, employment and the skills valued in the workplace. Learners can use the knowledge and skills gained from taking part in work-related experiences to develop successful enterprise activities. These can provide an authentic learning experience which helps them develop as creative, enterprising contributors, forming links to the world of work.

Effective careers guidance is essential in establishing the most appropriate route for learners' aspirations, informing them of the wide range of entry points and pathways into further learning and the world of work. Learners should have opportunities to foster entrepreneurial skills and to make them aware of the benefits of setting up an enterprise.

Understanding post-16 and higher education opportunities

It is essential for learners to be aware of all opportunities available to them post-16. Therefore, as well as understanding about employment, training and apprenticeships, learners should be provided with information and the opportunity to engage with a range of learning providers. Opportunities

for engagement should include attending careers and skills fairs, talks from and visits to further and higher education providers, as well as presentations from students in further or higher education. Learners should be directed to online research tools that provide course and progression information to support their understanding of the range of learning opportunities available, to help raise their aspirations and form a basis on which informed decisions can be made.

Relationships and sexuality education

Science and Technology offers learners the opportunity to study the scientific basis of relationships and sexuality education. Opportunities can be strengthened depending on practitioners' approach. There are clear links between this area of learning and experience and health and well-being.

Relationships

Through Science and Technology, learners will understand that the survival of the human race is based on relationships between individuals. This interdependency is essential for the continuation of life. Children, the elderly, and vulnerable individuals are more dependent on others.

Values, rights, culture and sexuality

Through the study of living things, learners will come to understand that we are all unique, due to genetic variation and environmental influence. Every human has a right to be respected and can contribute to society, regardless of their differences. We are all valuable and have a right to be treated with dignity and respect. Incorrect assumptions and stereotyping, which may lead to stigma and discrimination, can be harmful to individuals' well-being and violate their human rights. Scientific understanding by learners can help to dispel such assumptions and reduce stereotyping.

Understanding gender

Through the study of living things, learners will explore the difference between genetically determined sex as opposed to gender, and the importance of the difference between the two. Through this, learners will be able to understand that a person's gender identity may not match their biological sex.

Relationships and sexuality and health and well-being

The study of health and diseases provides learners with the opportunity to develop scientific understanding in support of their own informed decisions about their sexual health and well-being.

The human body and development

Through studying living things, learners will know the names and function of their sexual and reproductive organs. They will learn about the role hormones play in growth, puberty and reproduction, and how that can also affect people's emotions.

Sexuality and sexual behaviour

Through studying health and diseases, learners should be given opportunities to understand how contraceptives work, from a biological perspective, and their relative efficiency in preventing different sexually transmitted diseases. This knowledge enables them to make more informed decisions about their own sexual behaviour.

Enrichment and experiences

Enrichment and experiences are integral to Science and Technology and provide opportunities for all learners to experience holistic and authentic contexts. Through making fundamental connections within Science and Technology learners will develop a stronger understanding of the world around them and their place within it.

Exploration and experience of the world through inquiry (including fieldwork, investigating indoor and outdoor environments in a safe and systematic way) are crucial for all learners. Learners will enhance their understanding of different environmental issues and learn to demonstrate care, responsibility, concern and respect for all living things and the environment in which they live.

Developing a range of partnerships and engaging with science and technology professionals, experts and craftspeople can broaden experiences to deepen their understanding of processes and application. They should experience electronic and digital technologies to enhance their learning and deepen their understanding of future breakthroughs.

Learners should have opportunities to work both independently and collaboratively to investigate, design, develop and evaluate their outcomes. They should work iteratively towards a purposeful outcome to develop resilience and perseverance, where failure can be seen as a stepping stone to success and creativity is celebrated.

Putting the area of learning and experience into practice

The Science and Technology Area of Learning and Experience will need to be used by settings and schools with the four purposes of the curriculum central to the planning of the experiences, knowledge and skills learners will encounter. Therefore, practitioners must consider how their teaching and curriculum provision contribute to the development of these characteristics within learners in Wales.

As a matter of principle, practitioners should be free to decide on the organisation of this area of learning and experience, making important decisions about sequencing scientific and technological concepts. Such decisions should be informed by the hierarchic and connected nature of concepts set out in the area of learning and experience, including the range of suggested 'strands' of progression, in order to ensure foundations in learning are built on and experiences are connected.

Making the most of a multidisciplinary approach to curriculum development provides learners with a more coherent learning experience. Deep understanding can develop through planning across all six statements of what matters in science and technology learning, and the connection and application of these in a range of contexts. The learning undertaken in one aspect can reinforce and support work across different disciplines in a timely manner. To achieve this, cohesive and coherent curriculum planning across traditional disciplinary boundaries is crucial. However, practitioners will also wish to consider the need for more discrete disciplinary learning and teaching; this becomes increasingly important as learners progress.

The planned sequencing of Science and Technology learning and teaching should consider the development of the knowledge or skills learners need, in advance of engaging them in more practical activities or inquiry. Practical learning experiences of a specific, thematic or multidisciplinary nature should strengthen prior learning and conceptual understanding, not simply engage learners in memorable and enjoyable tasks. As learners progress in their Science and Technology learning, particularly in secondary settings, there is an expectation that they will experience subject specialist teaching. Specialist teaching should enhance and be integral to multidisciplinary approaches to curriculum planning, and is essential to ensure learners are best prepared for further learning post-16. Standards and rigour should be advanced by this process.

Teaching should also be based on sound evidence and expertise. Evidence should be drawn from local, cluster-wide, regional and national information, using a range of established sources, e.g. the National Network for Excellence in Science and Technology. Practitioners should also seek to collaborate with a range of experts and stakeholders when engaging in curriculum development, including local businesses and science, technology, engineering and mathematics stakeholder organisations.

WHAT MATTERS IN SCIENCE AND TECHNOLOGY

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We need to be able to evaluate scientific claims to help us make informed decisions that affect our world and well-being. The choices we make depend on many factors, including our moral viewpoints and personal beliefs. However, rigorous and robust evidence-based research provides us with a solid foundation on which to base our decisions. As ethically informed citizens we need to consider the impact of our actions and technological developments on Wales and the wider world, asking ‘Just because we can, does that mean we should?’.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from concrete to abstract.
- Learners develop from qualitative description to quantification.
- Learners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and progress to consider multiple factors.
- Learners develop simple skills into more elaborate skills.
- Learners begin with an egocentric view but develop to be able to consider others and the wider world.

Progression step 1

Achievement outcomes

Inquiry

I can show curiosity and question how things work.

I can explore my environment, make observations and communicate my ideas about what is happening.

Progression step 2

Achievement outcomes

Inquiry

I can ask questions and use my experience to suggest simple methods of inquiry.

I can collect data and communicate my findings.

I can recognise trends and patterns from my observations and investigations.

Impact of Science and Technology

I can recognise that what I do, and the things I use, can have an impact on my environment and on living things.

I can suggest how to use and dispose of everyday materials responsibly.

Progression step 3

Achievement outcomes

Inquiry

I can suggest suitable methods of inquiry, identifying variables where appropriate, to investigate scientific questions.

I can collect and present data in a suitable format.

I can identify trends, patterns and relationships to draw conclusions.

I can evaluate methods and working practices to suggest improvements.

Models

I can use physical and conceptual models to represent the behaviour of real-world physical and digital systems.

Evaluating evidence

I can engage with scientific and technological issues to inform my own opinions.

Impact of Science and Technology

I can take responsible actions in my daily life that take into account the impact on the environment and others.

I can describe the positive and negative impacts of Science and Technology in my everyday life.

I can identify which of the Earth's resources are in short supply and describe how they can be used sustainably.

Progression step 4

Achievement outcomes

Inquiry

I can research and suggest suitable methods of inquiry, identifying and managing variables, to investigate scientific questions.

I can collect reliable data, process and present it accurately in a suitable format.

I can describe trends, patterns and relationships in data, and use my scientific knowledge to explain them.

I can use my findings to draw valid conclusions.

I can evaluate the reliability of data, taking anomalies into account.

Models

I can make and use physical, mathematical and conceptual models to explain and predict the behaviour of real-world systems.

I can describe the strengths and weaknesses of models to identify their limitations.

Evaluating evidence

I can select relevant scientific knowledge from a range of evidence sources to evaluate claims presented as scientific facts.

I can review my own opinions based on new scientific evidence.

Impact of Science and Technology

I can explain why we sometimes choose to act in ways that impact negatively on the environment.

I can describe the positive and negative impacts of Science and Technology on society.

I can analyse the availability of key natural resources.

Progression step 5

Achievement outcomes

Inquiry

I can devise and justify systematic methods of inquiry to investigate scientific questions rigorously.

I can identify and describe complex trends, patterns and relationships.

I can link experimental findings and theoretical knowledge to draw valid conclusions.

I can critically evaluate the quality of data and suggest improvements to associated research methods.

Models

I can form physical, mathematical and conceptual models to explain and predict the behaviour of real-world systems.

I can use models to support or challenge theories.

I can evaluate the effectiveness of models and refine them to better fit the evidence available.

Evaluating evidence

I can research and evaluate claims presented as scientific facts by considering the validity of the supporting evidence.

I can evaluate alternative theories, where the evidence available does not conclusively support one outcome, to form a considered opinion.

Impact of Science and Technology

I can explain and justify ways in which society can develop, taking into account environmental and societal impacts both now and in the future.

I can evaluate the effectiveness and impact of technological solutions on a personal, societal and environmental level.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- The exploration of living things, including natural habitats, when undertaking inquiries.
- Inquiries into the physical properties of materials and the particulate nature of matter.
- Investigating the structure and dynamics of the universe.
- Supporting engineering problems and enhancing the design process.
- Understanding the role of Science and Technology, and challenging assumptions, with links to contextualised opportunities to articulate opinions and debate claims based on the validity of information.
- Engaging in learning on the implications of Science and Technology, with connections to design, engineering, computation and the sciences to provide rich opportunities and contexts.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Health and Well-being

- Decision-making and the implications of decisions.
- Personal well-being and decisions on safety.

Humanities

- The development of inquiry skills.

Languages, Literacy and Communication

- Communicating findings and opinions, presenting arguments.
- Access to non-fiction text types, including instructional and explanation writing.

Mathematics and Numeracy

- Number, data and statistics.
- Presentation of findings from inquiry.

Experiences, knowledge and skills

Progression step 1

Inquiry

Learners need to experience:

- multisensory experiential learning
- a rich learning environment indoors and outdoors
- using a range of tools to observe and explore, e.g. magnifying tools and cameras.

Learners need to be able to:

- follow simple instructions and work safely.

Progression step 2

Inquiry

Learners need to experience:

- adults showing them how to make connections between life experiences and investigations
- different types of inquiry, including out-of-classroom learning, pattern seeking, classifying and identifying, exploring, making things and investigating models.

Learners need to be able to:

- work safely and be aware of risks
- use a range of appropriate scientific equipment to observe, measure and record.

Impact of Science and Technology

Learners need to experience:

- opportunities to reduce, reuse and recycle.

Learners need to know:

- that some of their actions may impact on their local environment and the wider world.

Progression step 3

Inquiry

Learners need to experience:

- using technologies, directly or indirectly, to observe a range of phenomena
- different types of inquiry, including out-of-classroom learning, fair testing, pattern seeking, classifying and identifying, exploring, making things and investigating models.

Learners need to know:

- how different types of variables may impact on results of investigations.

Learners need to be able to:

- make predictions when appropriate
- be aware of risks and take necessary actions to control risks and hazards
- use a range of appropriate equipment and digital technology to observe, measure and record.

Models

Learners need to experience:

- using models to develop understanding.

Evaluating evidence

Learners need to experience:

- a range of scientific claims, including those which are current or which are relevant to their everyday lives
- opportunities to debate and articulate opinions about scientific claims.

Learners need to know:

- that current and past scientific investigation and technological developments can have both positive and negative effects on society.

Learners need to be able to:

- consider the credibility of evidence.

Impact of Science and Technology

Learners need to experience:

- debating the benefits and drawbacks of technology and scientific activity
- researching the effects of human activity on their local environment and the wider world.

Learners need to know:

- how industry past and present has impacted on human health and the environment.

Learners need to be able to:

- describe how the choices we make affect the natural world, society, ourselves and others
- develop and evaluate informed strategies to minimise the negative impact of human activity.

Progression step 4

Inquiry

Learners need to experience:

- using technologies, directly or indirectly, to observe a range of scientific and technological phenomena
- different types of inquiry, including out-of-classroom learning, fair testing, pattern seeking, classifying and identifying, exploring, making things and investigating models.

Learners need to know:

- how to recognise different types of variables and how they may impact on the results of investigations
- when digital technologies can enhance an inquiry.

Learners need to be able to:

- make predictions when appropriate
- identify risks and take necessary actions to control risks and hazards
- choose and use a range of appropriate equipment and digital technology to observe, measure and record.

Models

Learners need to know:

- that some models are essential in developing an understanding of key scientific and technological ideas.

Learners need to be able to:

- use models to explain and predict behaviour under a range of different conditions
- use, make, evaluate and refine models.

Evaluating evidence

Learners need to experience:

- a range of scientific claims that vary in terms of validity, reliability and credibility
- opportunities to debate and articulate opinions about scientific claims.

Learners need to know:

- that current and past scientific investigation and technological developments can have both positive and negative effects on society.

Learners need to be able to:

- filter evidence in terms of its validity, reliability and credibility.

Impact of Science and Technology

Learners need to experience:

- debating the benefits and drawbacks of technology and scientific activity
- researching the effects of human activity on their local environment and the wider world.

Learners need to know:

- how industry past and present has impacted on human health and the environment
- why some scientific and technological developments have been controversial.

Learners need to be able to:

- describe how the choices we make affect the natural world, society, ourselves and others
- develop and evaluate informed strategies to minimise the negative impact of human activity
- explain how a range of factors, including environmental and economic considerations, have shaped society's decisions.

Progression step 5

Inquiry

Learners need to experience:

- using technologies, directly or indirectly, to observe a range of scientific and technological phenomena
- different types of inquiry, including out-of-classroom learning, fair testing, pattern seeking, classifying and identifying, exploring, making things and investigating models.

Learners need to know:

- how to recognise different types of variables and how they may impact upon results of investigations
- when digital technologies can enhance an inquiry.

Learners need to be able to:

- make predictions when appropriate
- identify risks and take necessary actions to control risks and hazards
- choose and use a range of appropriate equipment and digital technology to observe, measure and record.

Models

Learners need to experience:

- comparing and contrasting different models
- studying previous models and how they have been advanced and refined due to scientific and technological discoveries

- utilising their analytical and creative skills to produce models
- using models to solve problems and overcome challenges.

Learners need to know:

- that some models are essential in developing an understanding of key scientific and technological ideas.

Learners need to be able to:

- use models to explain and predict behaviour under a range of different conditions
- construct, use, evaluate and refine models.

Evaluating evidence

Learners need to experience:

- a range of evidence that varies in terms of validity, reliability and credibility
- opportunities to debate and articulate opinions about evidence.

Learners need to know:

- that current and past scientific investigation and technological developments can have both positive and negative effects on society.

Learners need to be able to:

- filter evidence in terms of its validity, reliability and credibility.

Impact of Science and Technology

Learners need to experience:

- debating the benefits and drawbacks of technology and scientific activity
- researching the effects of human activity on their local environment and the wider world.

Learners need to know:

- how industry past and present has impacted on human health and the environment
- why some scientific and technological developments have been controversial.

Learners need to be able to:

- describe how the choices we make affect the natural world, society, ourselves and others
- develop and evaluate informed strategies to minimise the negative impact of human activity
- explain how a range of factors, including environmental and economic considerations, have shaped society's decisions.

WHAT MATTERS IN SCIENCE AND TECHNOLOGY

Design thinking and engineering are technical and creative endeavours intended to meet society's needs and wants.

In Science and Technology, learners use experiences and apply their skills and knowledge to design and shape innovative engineered solutions. As part of a user-centred design process, we develop ideas, manage and mitigate risks, and minimise complexities. When we engineer products, services and systems, we need to understand and control the interactions between materials, components, structures and users. The application of engineering processes allows learners to develop accuracy, precision, dexterity and craftsmanship. By designing and engineering outcomes in response to needs, wants or difficulties, learners become enterprising problem-solvers who are well placed to contribute to society.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from abstract to concrete.
- Learners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and develop to be able to consider multiple factors.
- Learners develop simple skills through imitation and manipulation, moving towards more elaborate skills that enable perfecting and articulating.
- Learners begin with an egocentric view but progress to consideration of others and of the wider world.
- Learners move from imitation to the creation of original content.

Progression step 1

Achievement outcomes

Design context and innovative thinking
I can design while I make during play.

Design communication
I can communicate about what I am making.

Prototyping and making
I can safely use simple tools, materials and equipment to construct and deconstruct.

Progression step 2

Achievement outcomes

Design context and innovative thinking
I can produce designs from my own ideas in response to particular contexts.

Design decision-making
I can make design decisions using my knowledge of materials and existing products.

I can improve my designs as a result of evaluation.

Design communication
I can communicate my design ideas before making.

Systems thinking

I can explore how different component parts work together.

Prototyping and making

I can safely use a range of tools, materials and equipment to construct for a variety of reasons.

I can use basic prototyping to improve my outcomes.

Progression step 3

Achievement outcomes

Design context and innovative thinking

I can creatively respond to the needs and wants of the user, based on the context and on the evidence collected.

Design decision-making

I can identify and consider factors and limitations when developing design proposals.

I can test and refine my design decisions without fear of failure.

I can apply my knowledge and skills to make my design decisions.

I can consider how my design proposals will improve on existing products and how they may affect the environment.

Design communication

I can use communication methods to develop and present ideas clearly, and to respond to feedback.

Systems thinking

I can combine component parts, materials and processes to achieve functionality and improve the effectiveness of my outcome.

Prototyping and making

I can select and safely use appropriate tools, materials and equipment to methodically construct purposeful outcomes.

I can use prototyping as a link between my designing and making.

I can work responsibly, taking into account environment and societal impacts.

Progression step 4

Achievement outcomes

Design context and innovative thinking

I can draw inspiration from, investigate and analyse a range of sources, and use these when working in real-world contexts.

I can recognise and act upon user needs and wants in increasingly challenging contexts.

Design decision-making

I can identify and prioritise factors and limitations to inform my design proposals.

I can adopt an iterative process that informs and improves my design thinking.

I can use new knowledge and skills to support my design decisions.

I can adapt and improve my design proposals while minimising the negative impact on the environment and society.

Design communication

I can use a variety of design communication methods and techniques to develop and present ideas clearly, and I can respond constructively to feedback during this process.

Systems thinking

I can investigate, evaluate, select and combine component parts, materials or processes to improve the functionality and effectiveness of my outcome.

Prototyping and making

I can select and safely use specialist tools and techniques in order to improve the efficiency of my product development.

I can use prototyping techniques to test ideas and support my making.

I can use my making skills and knowledge of materials to produce quality and purposeful outcomes.

I can evaluate and apply responsible habits of working which take into account environmental and societal impacts.

I have considered how users and wider society will interact with the outcomes I produce.

Progression step 5

Achievement outcomes

Design context and innovative thinking

I can analyse and draw inspiration from multiple sources to generate proposals that are innovative and diverse.

I can tackle challenging problems, on my own and with others, to address design requirements in increasingly unfamiliar contexts.

Design decision-making

I can prioritise and justify multiple design factors and limitations to improve the effectiveness of my design decisions.

I can iteratively evaluate and modify my design proposals when tackling challenging problems.

I can independently identify strategies to develop my design solutions.

I can consider both potential intended and unintended consequences of my designs, and those of others, in order to adapt and justify proposals.

Design communication

I can communicate my design thinking effectively and engage constructively with the feedback I receive to address the needs and wants of users.

Systems thinking

I can independently select, justify and combine component parts, materials and processes to improve functionality.

I can continually evaluate the effectiveness of my outcome.

Prototyping and making

I can select and perform complex multi-stage tasks independently, safely and effectively, while using specialist equipment with precision.

I can independently select and apply high-fidelity and low-fidelity prototyping to test ideas, materials and structures, highlighting issues and exploring concepts.

I can use my making skills and knowledge of materials to produce high-quality and effective outcomes.

I can apply and justify responsible habits of working which account for environmental and societal impacts.

I can analyse and evaluate the success of an outcome on many levels, including its impact on the user and wider society.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- The composition, properties and uses of materials links to the atomic nature of matter.
- The implications of scientific developments and resource limitations on design decisions, including environmental, social, cultural and ethical issues.
- The role of energy in design and engineered systems.
- Living things and how nature provides inspiration for design.
- Scientific and technological reasoning regarding observing, measuring and predicting when making design decisions, including sourcing and physical properties of materials.
- Energy and forces for underpinning principles used for powering and controlling outcomes.
- The framework for creating innovative creative outcomes expressed through computation.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Expressive Arts

- The processes of designing and making.
- Developing motor skills in using tools.
- Creativity in design.
- The use of materials, equipment and sound.

Health and Well-being

- Nutrition and food technology.

Humanities

- Inquiry using sources and evidence.
- People in past societies and their influence on today.
- The evolution of Science and Technology.
- The effects of waste and use of natural resources on the environment.
- Social, economic and technological developments and their effect on employment.
- Entrepreneurship and design technology.

Languages, Literacy and Communication

- Communicating opinions and design, presenting explanations.
- Access to factual texts.

Mathematics and Numeracy

- The consideration of variables and the development of reasoning.
- Calculating in space and shape.
- The presentation of findings from design.

Experiences, knowledge and skills

Progression step 1

Design context and innovative thinking

Learners need to experience:

- rich indoor and outdoor environments that support making.

Design communication

Learners need to experience:

- opportunities, while they are making, to communicate their design ideas to an adult
- adults playing alongside them and supporting their thinking through sensitive questioning.

Prototyping and making

Learners need to experience:

- using a range of tools and equipment safely indoors and outdoors.

Learners need to be able to:

- manipulate a range of materials, and use tools with increasing dexterity.

Progression step 2

Design context and innovative thinking

Learners need to experience:

- opportunities to design innovatively for a range of contexts, situations and audiences
- opportunities to express their ideas through trial and improvement when designing.

Learners need to be able to:

- find out about different cultures and contexts to support their design thinking
- understand that there is often more than one solution
- consider needs and wants regarding end users.

Design decision-making

Learners need to experience:

- opportunities to develop and improve design proposals, through questioning and evaluating with peers, in a supportive environment
- how design tools and strategies can support them in their decision-making.

Learners need to be able to:

- consider contexts before developing appropriate design proposals

- use existing examples to drive their design thinking
- consider environmental issues within their proposals.

Design communication

Learners need to experience:

- opportunities to communicate and present design ideas to others in a range of different ways before making.

Systems thinking

Learners need to experience:

- opportunities to adopt a systems-thinking approach that considers how multiple components are integrated as part of the making process.

Learners need to be able to:

- engineer or create outcomes that involve aspects of control, power and structure.

Learners need to know:

- how the properties of materials affect the functionality of outcomes.

Prototyping and making

Learners need to experience:

- making a range of things, indoors and outdoors, for a variety of reasons
- opportunities to engage in both physical and digital making
- engineering or making processes and their application in local areas, through engaging with professionals, experts and craftspeople.

Learners need to be able to:

- use a wider range of tools and equipment with increasing dexterity, skill and safety
- manipulate a wider range of materials
- apply knowledge and understanding of the properties of materials to support prototyping and making.

Progression step 3

Design context and innovative thinking

Learners need to experience:

- opportunities, where possible, to design in authentic real-life contexts, while also considering speculative future contexts for a range of situations and audiences
- opportunities for innovative designing that are beyond the constraints of their practical skills, and the availability of materials and equipment.

Learners need to know:

- about different cultures and contexts, where appropriate, to support their design thinking.

Learners need to be able to:

- apply creativity and imagination to understand that there is often more than one solution
- apply innovative thinking through measured risk-taking and a trial-and-improvement approach
- develop empathy through considering the needs and wants of end users.

Design decision-making

Learners need to experience:

- opportunities to examine existing products to inform their designing
- opportunities to develop and improve design proposals, through questioning and evaluating with peers, in a supportive environment
- using design tools and strategies to support them in their decision-making.

Learners need to know:

- about the work of designers across several disciplines and contexts to inform their own design thinking.

Learners need to be able to:

- justify design decisions based on factors, e.g. aesthetic, constructional and marketing considerations
- use primary and secondary sources to investigate context and drive their design thinking
- consider environmental and ethical issues in their proposals.

Design communication

Learners need to experience:

- opportunities where they can develop visual literacy skills.

Learners need to be able to:

- develop and select the most appropriate visual communication methods that support development of design ideas
- use prototyping as a form of design communication.

Systems thinking

Learners need to experience:

- how both collaborative and independent working leads to effective engineering outcomes.

Learners need to know:

- how the properties of appropriate materials and the effectiveness of techniques will affect the functionality of outcomes
- about a systems-thinking approach that considers how multiple components are integrated as part of the making process.

Learners need to be able to:

- engage in making that combines components in a system to give structure, control and power.

Prototyping and making

Learners need to experience:

- opportunities to work in different environments
- engagement with professionals, experts and craftspeople to broaden their experiences of engineering processes
- opportunities to develop practical making skills without the need for designing.

Learners need to be able to:

- apply their knowledge of the working properties of materials and associated techniques to support prototyping and making
- develop manual dexterity, accuracy, precision and craftsmanship through use of tools, utensils, equipment, appropriate materials and ingredients
- engage in physical, electronic and digital making.

Progression step 4

Design context and innovative thinking

Learners need to experience:

- opportunities, where possible, to design in authentic real-life contexts, while also considering speculative future contexts for a range of situations and audiences
- opportunities for innovative designing that are beyond the constraints of their practical skills, and the availability of materials and equipment.

Learners need to be able to:

- acquire and apply new knowledge of different cultures and contexts to inform their design thinking
- apply creativity and imagination to understand there is often more than one solution

- adopt innovative thinking through measured risk-taking and a trial-and-improvement approach.

Design decision-making

Learners need to experience:

- opportunities to examine existing products to inform their designing
- using design tools and strategies to support them in their decision-making.

Learners need to know:

- about the work of designers across a range of disciplines and contexts to inform their own design thinking
- about emerging materials and technologies, and the new properties and possibilities they offer
- about circular design approaches and planned obsolescence.

Learners need to be able to:

- analyse contexts and develop design proposals through questioning and evaluating with others
- justify design decisions based on factors such as conceptual, technical, aesthetic, constructional and marketing considerations
- apply technological and scientific knowledge to support design decisions
- investigate and analyse primary and secondary sources to inspire design thinking
- consider environmental, social, cultural and ethical issues within their proposals.

Design communication

Learners need to experience:

- opportunities where they can develop their visual literacy skills.

Learners need to be able to:

- use prototyping as a form of design communication
- select and apply the most effective methods for both communication and developing their ideas, and respond constructively to feedback from knowledgeable others.

Systems thinking

Learners need to experience:

- how both collaborative and independent working leads to effective engineering outcomes
- how systems and processes are used in engineering and manufacturing environments.

Learners need to know:

- how the properties of materials will affect the functionality of outcomes.

Learners need to be able to:

- apply a systems-thinking approach where multiple components or parts are integrated in the making process
- engage in making that combines components into a system that gives structure, control and power.

Prototyping and making

Learners need to experience:

- engagement with professionals, experts and craftspeople to broaden their experiences of engineering and making processes
- using high-fidelity and low-fidelity prototyping to test ideas, materials and structures, highlighting issues and exploring concepts
- opportunities to develop practical making skills without the need for designing.

Learners need to know:

- the interdisciplinary nature of engineering across a breadth of disciplines.

Learners need to be able to:

- apply knowledge and understanding of the working properties of a range of materials and associated techniques to support prototyping and making
- develop manual dexterity, accuracy, precision and craftsmanship through use of a range of tools, utensils, equipment, materials and ingredients
- engage in both physical, electronic and digital making.

Progression step 5

Design context and innovative thinking

Learners need to experience:

- opportunities for innovative designing that are beyond the constraints of their practical skills, and the availability of materials and equipment.

Learners need to be able to:

- independently identify authentic real-life contexts, while also considering speculative future contexts, for a range of situations and audiences
- acquire and creatively apply new knowledge of different cultures and contexts to inform their design thinking
- utilise their creativity and imagination to explore numerous proposals
- implement a trial-and-improvement approach through testing, where measured risk-taking leads to innovative thinking.

Design decision-making

Learners need to know:

- about emerging materials and technologies and the new properties and possibilities they offer.

Learners need to be able to:

- use their knowledge and understanding of the work of designers from a range of disciplines and contexts to inform their own design thinking
- analyse existing products with a view to informing their own design work
- analyse contexts and develop design proposals through questioning and evaluating with others
- select and use a range of design tools and strategies
- justify design decisions based on factors such as conceptual, technical, aesthetic, constructional and marketing considerations, and the interdependence between these
- apply technological and scientific knowledge to support design decisions
- investigate and analyse primary and secondary sources to inspire design thinking
- adopt circular design approaches and consider planned obsolescence
- consider environmental, social, cultural and ethical issues within their proposals.

Design communication

Learners need to be able to:

- use their visual literacy skills to communicate their design ideas fluently
- use prototyping as a form of design communication
- choose and apply the most effective methods for both communicating and developing their ideas, and respond constructively to feedback from knowledgeable users.

Systems thinking

Learners need to experience:

- how both collaborative and independent working leads to effective engineering outcomes
- how systems and processes are used in engineering and manufacturing environments.

Learners need to be able to:

- know and apply the properties of materials to realise or improve the functionality of outcomes
- apply a systems-thinking approach where multiple components or parts are integrated in the making process
- engage in making that combines components in a system that gives structure, control and power.

Prototyping and making

Learners need to experience:

- engagement with professionals, experts and craftspeople to broaden their experiences of engineering and making processes
- opportunities to develop practical making skills without the need for designing.

Learners need to know:

- of the integral nature of engineering across a breadth of disciplines.

Learners need to be able to:

- apply knowledge and understanding of the working properties of a range of materials and associated techniques to support prototyping and making
- refine manual dexterity, accuracy, precision and craftsmanship through use of a range of tools, utensils, equipment, materials and ingredients
- engage in both physical, electronic and digital making.

WHAT MATTERS IN SCIENCE AND TECHNOLOGY

The world around us is full of living things which depend on each other for survival.

In Science and Technology, we recognise that living things are diverse, interacting with their environment and evolving over generations. All living things require specific conditions and resources to survive and they may have to compete with other organisms to do so. Humans form part of the living world and our decisions and actions, along with natural selection, can have a significant impact on the diversity of life. Knowing about the structures and functions of living things enables us to understand how they grow, develop and reproduce successfully. Developing an understanding of harmful factors in our environment allows us to make informed decisions, including about seeking prevention and treatments for diseases.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from concrete to abstract.
- Learners develop from qualitative description to quantification.
- Leaners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and develop to be able to consider multiple factors.
- Learners develop simple skills into more elaborate skills.
- Learners begin with an egocentric view but develop to be able to consider others and the wider world.

Progression step 1

Achievement outcomes

Diversity of life

I can recognise that plants and animals are living.

I can recognise that living things grow.

I can identify living things in their natural habitats.

Health and disease

I can observe, with an adult, things in the environment that may cause harm.

Progression step 2

Achievement outcomes

Diversity of life

I can recognise and compare some features of living things and discuss similarities and differences.

I can compare and contrast how living things develop and have offspring.

I can explore how different habitats provide resources for living things to survive.

Biological processes

I can identify parts of living things and their function.

Health and disease

I can identify things in the environment which may be harmful and can act to prevent harm to myself and others.

Progression step 3

Achievement outcomes

Diversity of life

I can use scientific criteria to describe the features of living things and use these to classify.

I can describe how living things have changed over generations.

I can describe how living things compete for specific resources and depend on each other for survival.

I can discuss the positive and negative impact that changes in the environment and human activity have on living things and habitats.

Biological processes

I can name and describe the functions of organs within my body and in plants.

I can describe how some organs work together to perform a function.

Health and disease

I can describe the impact of lifestyle choices on organ systems, development and health.

I can identify ways in which the body can defend itself from infection.

Progression step 4

Achievement outcomes

Diversity of life

I can explain how adaptation of organisms can affect their chances of survival.

I can explain how reproduction, mutations and the environment can lead to variation.

I can explain the interdependence of organisms in an ecosystem and how this leads to survival.

I can analyse how environmental factors and human activity can contribute to changes in habitats and population size.

Biological processes

I can describe cells within organisms and relate structure to function.

I can describe biological processes within organisms and explain how these contribute to their development and survival.

I can describe the changes caused by hormones at puberty, which helps me to understand development and growth.

Health and disease

I can explain the effect of different lifestyle choices on organ systems and their impact on health.

I can distinguish between diseases caused by pathogens and those caused by genetic inheritance in order to determine appropriate treatments.

I can describe how the body defends itself from infections caused by pathogens.

Progression step 5

Achievement outcomes

Diversity of life

I can explain the relationship between the environment and natural selection, and can connect and apply this to my understanding of evolution and extinction.

I can apply my knowledge of the different types of cell division to explain how this can lead to genetic variation.

I can describe the development of gene technology and critically evaluate its impact on society.

I can explain the importance of nutrient cycles for the continuation of life.

I can evaluate contemporary issues that affect biodiversity, including environmental factors and human activity.

Biological processes

I can explain how organisms function through exchange and transport, coordination and control, photosynthesis and cellular respiration.

I can explain how the internal environment of organisms is regulated to maintain life.

I can explain the role of hormones in growth and sexual reproduction.

Health and disease

I can explain the mechanism of genetic crosses to predict the inheritance of disorders.

I can explain how pathogens may cause diseases and how the mechanisms of the body, along with medical intervention, prevent and combat these diseases.

I can explain the beneficial role of microbes in the defence against diseases.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- Undertaking scientific inquiry and use of models.
- Understanding the implications of scientific development.
- Using tools and equipment.
- The nature of matter and its properties.
- The transfer of energy.
- Rates of biological reactions.
- Genetic engineering and its impact.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Health and Well-being

- The biological aspects of physical growth, health and well-being (including impact of disease, reproduction, physical activity and nutrition).
- The relationship between physiology and mental and emotional health (including growth and the structure of the human brain).
- Making informed decisions about our health and the health of other living things.

Humanities

- Inquiry using sources and evidence.
- Environmental science, sustainability and agriculture.
- The effects of waste and use of natural resources on the environment.
- The effects of human activity on biodiversity.

Languages, Literacy and Communication

- Access to factual texts.

Mathematics and Numeracy

- The use of number, data, classification and statistics.
- The presentation of findings from inquiry.
- Using formula.

Experiences, knowledge and skills

Progression step 1

Diversity of life

Learners need to experience:

- observing living things
- growing living things
- exploring natural habitats, including microhabitats, e.g. under a stone, under a plant pot, cracks in walls and compost areas.

Progression step 2

Diversity of life

Learners need to be able to:

- communicate differences and similarities in living things, using observable features to sort and group.

Biological processes

Learners need to experience:

- how things move, grow, and sustain life, e.g. growing vegetables, observing at first hand physical changes in humans and animals.

Learners need to know:

- the names of some internal and external parts of living things
- that living things reproduce and have life cycles.

Health and disease

Learners need to know:

- that things, both seen and not seen, can harm us, e.g. the spread of germs, poison (including plants) and inappropriate use of medicines.

Progression step 3

Diversity of life

Learners need to experience:

- exploring natural habitats, using identification keys and sampling techniques to measure biodiversity
- using models to understand feeding relationships, e.g. food chains and food webs

- investigating some of the conditions living things need in order to survive.

Health and disease

Learners need to know:

- that lifestyle choices, including diet and drug misuse, may impact on the body
- about the natural barriers of the body, e.g. tears, skin and mucus.

Progression step 4

Diversity of life

Learners need to experience:

- the collection of data from natural habitats via sampling techniques to measure biodiversity
- using indicator species to investigate pollution
- using models to represent interdependence.

Learners need to know:

- that genetic information is stored in DNA and transferred from one generation to the next
- how energy is transferred through an ecosystem.

Biological processes

Learners need to experience:

- observing cells
- investigating the internal structures of plants or animals
- using models to represent biological processes
- investigating biological processes such as respiration, photosynthesis and digestion.

Health and disease

Learners need to know:

- that bacteria, viruses and fungi that cause disease are known as pathogens
- that white blood cells contribute to the immune response.

Progression step 5

Diversity of life

Learners need to experience:

- the collection of data from different habitats via sampling techniques to compare biodiversity
- using and constructing models to understand interdependence, nutrient cycles and inheritance.

Biological processes

Learners need to experience:

- using models to explain biological processes
- investigating the factors which affect biological processes.

Health and disease

Learners need to experience:

- growing microbes aseptically.

Learners need to know:

- about the development of new treatments for diseases, including drugs, vaccines and stem cells.

Learners need to be able to:

- evaluate the effect of medical interventions on human health, e.g. vaccination programmes, overuse of antibiotics and use of fluoride.

WHAT MATTERS IN
SCIENCE AND TECHNOLOGY

Understanding the atomic nature of matter and how it shapes the world.

In Science and Technology, understanding matter and its properties enables us to recognise the role that chemistry plays in the world around us. Similarly, being able to separate, identify and manipulate substances helps us to better understand both what our world and our bodies are made of. As we then develop a deeper understanding of matter and its properties, we can design and create new substances and materials that can enrich our lives. This activity is particularly relevant in Wales, where it has had significant industrial application and where innovation continues.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from concrete to abstract.
- Learners develop from qualitative description to quantification.
- Learners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and develop to be able to consider multiple factors.
- Learners develop simple skills into more elaborate skills.
- Learners begin with an egocentric view but develop to be able to consider others and the wider world.

Progression step 1

Achievement outcomes

Properties of materials
I can explore the properties of materials and choose different materials for a particular use.

Chemical reactions
I can mix different materials during play.

Progression step 2

Achievement outcomes

Properties of materials
I can explore and describe the properties of materials and justify their uses.

Chemical reactions
I can observe and describe ways in which materials change when they are mixed together.

Extraction, refinement and analysis
I can explore ways to separate everyday materials.

Progression step 3

Achievement outcomes

Properties of materials

I can classify and compare different materials according to their physical properties and relate these to their use.

I can use observations to identify the effects of temperature change on materials.

I can recognise that mass is conserved when a substance changes state.

Chemical reactions

I can use everyday chemicals to demonstrate chemical reactions and can identify some of the signs of a chemical reaction.

Extraction, refinement and analysis

I can use my knowledge and experiences of materials to select the appropriate techniques for separating a range of mixtures.

I can recognise that the Earth provides the materials that we use and can describe the limitations that these materials have in their natural form.

Progression step 4

Achievement outcomes

Structure of materials

I can use the particle model to describe and explain the composition of elements, compounds and mixtures.

Properties of materials

I can describe and explain the properties of elements, compounds and mixtures, and relate these to how they are used.

I can use the particle model to explain the properties and behaviours of substances in different states.

Chemical reactions

I can describe different types of chemical reactions, explain their uses and identify any effects of the products formed.

I can use my knowledge of chemical reactions to explain what happens to the rate of reaction when certain conditions are changed.

I can apply my knowledge of chemical reactions to describe how mass is conserved during a chemical change.

Extraction, refinement and analysis

I can apply my knowledge of the properties of materials to select and use the appropriate technique in order to separate mixtures.

I can describe different chemical indicator tests and use these both to identify substances and to compare and classify materials.

I can identify that materials are obtained from the Earth's natural resources and can explain why they are finite.

Progression step 5

Achievement outcomes

Structure of materials

I can apply my knowledge of atomic and electronic structure to explain the bonding and structure of different types of materials.

I can suggest the type of bonding in a substance based on its properties.

Properties of materials

I can use my knowledge of atomic structure and bonding to explain and predict the properties of materials and to justify their use.

I can compare the nature and properties of different types of nuclear radiation and justify the use of radioactive isotopes for a specific purpose.

Chemical reactions

I can apply my knowledge of the structure and properties of materials to explain reactivity in different types of chemical reactions.

I can use my knowledge of particle theory to explain how reactions can be controlled in order to attain the optimum conditions for industrial reactions.

I can apply my knowledge of the principles of conservation of mass and symbol equations to explain, predict and calculate the quantities and energy changes involved in chemical reactions.

Extraction, refinement and analysis

I can use my knowledge and understanding of matter to explain how different techniques can be used to extract and refine substances for a variety of uses.

I can use chemical tests to analyse materials, and can apply my knowledge of chemical reactions in order to identify substances and their composition.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- Undertaking scientific inquiry and use of models.
- Considering the impact of the use of materials and reactions.
- Understanding the implications of scientific development.
- Using materials and equipment.
- The uses and properties of materials in design and engineering.
- Electricity and nuclear radiation.
- The biological reactions of photosynthesis and respiration.
- Energy changes and conservation of mass.
- Extraction, refinement and analysis, and their links to food groups.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Health and Well-being

- Cooking and the development of healthy eating.

Humanities

- Inquiry using sources and evidence.
- Physical geography and geology.
- Environmental science, sustainability (including renewable energy) and agriculture.
- The effects of waste and use of natural resources on the environment.

Languages, Literacy and Communication

- Access to factual texts.
- Instructional and explanation writing.

Mathematics and Numeracy

- Number, data, classification and statistics.
- The presentation of findings from inquiry.
- Clarification and identifying, estimating and measuring.
- Using formula.

Experiences, knowledge and skills

Progression step 1

Properties of materials

Learners need to experience:

- manipulating a range of materials during play and experiential learning.

Progression step 2

Properties of materials

Learners need to experience:

- manipulating a range of materials during play and experiential learning.

Learners need to be able to:

- communicate their ideas about the physical properties of materials and states, including solids, liquids and gases.

Chemical reactions

Learners need to experience:

- making new materials by mixing others, e.g. when cooking or when mixing bicarbonate of soda and vinegar.

Learners need to know:

- materials can change, and under certain conditions will react to form something new.

Progression step 3

Properties of materials

Learners need to experience:

- how the mass of a substance stays the same when it changes state.

Chemical reactions

Learners need to experience:

- everyday chemical reactions, e.g. striking a match, rusting and baking
- different indicators of chemical reactions, e.g. fizzing or the production of bubbles, colour change and heat emission.

Extraction, refinement and analysis

Learners need to experience:

- using a range of separation techniques, e.g. using magnets, filtering and evaporating.

Learners need to know:

- some examples of materials obtained from the Earth
- that the majority of raw materials have to be processed before they can be used.

Progression step 4

Structure of materials

Learners need to know:

- the arrangement of elements in the periodic table.

Learners need to be able to:

- distinguish between elements, compounds and mixtures.

Properties of materials

Learners need to know:

- how the properties of compounds are different from their constituent elements.

Chemical reactions

Learners need to experience:

- different types of chemical reactions, e.g. neutralisation, oxidation, and exothermic and endothermic reactions.

Learners need to know:

- that rates of reaction are affected by factors such as temperature, concentration and surface area.

Learners need to be able to:

- use word equations and interpret simple chemical formulae.

Extraction, refinement and analysis

Learners need to know:

- that specific techniques to separate and analyse are appropriate for different purposes, e.g. distillation, filtration and chromatography
- some examples of materials obtained from the Earth
- that the majority of raw materials have to be processed before they can be used
- about different chemical tests, e.g. food tests, flame tests and indicator tests.

Progression step 5

Structure of materials

Learners need to know about:

- the different types of bonding
- the types of atomic and molecular structure that exist.

Properties of materials

Learners need to know:

- the properties of metals and non-metals
- how the properties of materials are affected by their structures, e.g. conductivity, melting point and malleability
- about different types of radiation, e.g. alpha, beta and gamma.

Chemical reactions

Learners need to know:

- trends in reactivity in the periodic table.

Learners need to experience:

- different types of chemical reactions, e.g. displacement, reduction and polymerisation
- that rates of reaction are affected by other factors such as using a catalyst or changing the pressure.

Learners need to be able to:

- calculate the physical properties involved in reactions, e.g. masses, concentrations, volumes and energy.

Extraction, refinement and analysis

Learners need to know:

- methods of extraction, e.g. electrolysis, reduction and fractional distillation.

Learners are able to:

- apply different chemical tests.

WHAT MATTERS IN
SCIENCE AND TECHNOLOGY

Forces and energy determine the structure and dynamics of the universe.

In Science and Technology, forces and energy can be used to describe the behaviour of everything from the smallest building blocks of matter to the motion of stars and planets. Understanding forces and energy helps us to predict and control the behaviour of our surroundings. These ideas can be modelled and expressed formally, providing a consistent mathematical framework to describe physical systems. This has enabled some of society's greatest scientific breakthroughs and engineering achievements. As responsible citizens of Wales and the world, an understanding of forces and energy will help us overcome future challenges and use our planet's resources efficiently.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from concrete to abstract.
- Learners develop from qualitative description to quantification.
- Learners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and develop to be able to consider multiple factors.
- Learners develop simple skills into more elaborate skills.
- Learners begin with an egocentric view but develop to be able to consider others and the implications in the wider world.

Progression step 1

Achievement outcomes

Forces and motion
I can explore the way objects move.

Energy
I can explore energy through multisensory experiences.

Waves
I can explore light and shadows, and can communicate my ideas.

Magnetism
I can explore the effects of magnets through multisensory experiences.

Progression step 2

Achievement outcomes

Forces and motion
I can investigate and predict the effects of forces in everyday life.

Energy
I can identify some forms of energy through multisensory experience.

Electricity
I can explore how electricity behaves in simple circuits.

Waves
I can explore and communicate the basic properties of light and sound.

Magnetism
I can explore magnets and their properties through multisensory experiences.

Progression step 3

Achievement outcomes

Forces and motion
I can use models to describe the forces acting on an object.

I can explore how the motion of an object can be affected by applying forces.

Energy
I can describe how energy transfers or transforms from a store of energy to make everyday devices operate.

I can identify and explain that as one energy store increases another decreases.

Electricity
I can investigate and explain factors that affect electrical circuits.

Waves
I can investigate and explain the properties of different types of waves.

Magnetism
I can investigate magnetic fields in order to describe their effects and uses.

Progression step 4

Achievement outcomes

Forces and motion
I can use mathematical models to describe the forces acting on an object.

I can analyse the effects of forces.

Energy
I can apply the principle of the conservation of energy to a range of contexts and perform simple calculations.

Electricity

I can investigate different electrical circuits and describe relationships.

Waves

I can describe a range of waves, using key terms and values, and compare their behaviour.

Magnetism

I can investigate the factors that affect the strength and forms of magnetic fields.

Progression step 5

Achievement outcomes

Forces and motion

I can apply strategies independently and effectively to solve problems by modelling systems of forces.

I can investigate how and why bodies move with reference to relevant physical laws.

Energy

I can apply the principle of conservation of energy to a range of scenarios.

Electricity

I can investigate and analyse analogue and digital electrical circuits that involve a range of relevant components.

Waves

I can quantify the key features of waves and explain how their motion is affected when they travel through different media.

I can describe and explain the similarities and differences between analogue and digital communication techniques, and their respective advantages and disadvantages.

Magnetism

I can use models that describe the links between force, current and magnetic fields to explain a range of electromagnetic applications.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- Undertaking scientific inquiry and use of models.
- Understanding the implications of scientific development.
- Using tools and equipment.
- Understanding how energy and forces act within and on living things.
- The nature of matter and its properties.
- Digital electronic systems and computation.
- Digital electronics and communications.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Expressive Arts

- Use of materials, equipment and sound.
- Waves and digital music.

Humanities

- Inquiry using sources and evidence.
- Physical geography and geology.
- Environmental science, sustainability (including renewable energy).
- The effects of waste and use of natural resources on the environment.

Languages, Literacy and Communication

- Access to factual texts.

Mathematics and Numeracy

- Number, data, classification and statistics.
- The presentation of findings from inquiry.
- Clarification and identifying, estimating and measuring.
- Using formula.

Experiences, knowledge and skills

Progression step 1

Forces and motion

Learners need to experience:

- their own movement and the movement of objects in a variety of environments indoors and outdoors.

Energy

Learners need to experience:

- exploring energy during play in a rich, multisensory environment indoors and outdoors.

Waves

Learners need to experience:

- observing light and shadow in their natural environment
- opportunities to play with light and shadow.

Learners need to know:

- that they should protect their eyes from the sun.

Magnetism

Learners need to experience:

- playing with magnets.

Progression step 2

Forces and motion

Learners need to experience:

- motion in a range of contexts with opportunities to describe and measure observations
- representations of the solar system.

Learners need to be able to:

- observe the effects of forces on the motion of objects.

Energy

Learners need to experience:

- investigating the ways that energy can be stored and transferred, e.g. in springs and batteries.

Learners need to know:

- that most of the energy resources we utilise are derived from the sun's energy.

Electricity

Learners need to experience:

- constructing electrical circuits using a variety of materials.

Learners need to know:

- that some materials (conductors) allow electricity to flow, while some materials (insulators) stop its flow
- how to stay safe when using electricity.

Waves

Learners need to experience:

- opportunities to observe and describe wave phenomena
- concrete representations of waves during their play, e.g. in water, springs and ropes.

Learners need to know:

- that light is needed in order to see objects
- that sounds are caused by vibrations.

Magnetism

Learners need to experience:

- experimenting with magnetic fields.

Learners need to know:

- that some materials are magnetic and are affected by magnetic fields.

Progression step 3

Forces and motion

Learners need to experience:

- motion in a range of contexts with opportunities to measure, describe and quantify observations
- how forces and motion apply to celestial bodies in space.

Learners need to know:

- the relationship between force and motion.

Learners need to be able to:

- describe the effects of forces on the motion of objects.

Energy

Learners need to experience:

- investigating ways energy can be stored and transferred.

Learners need to know:

- that most of the energy resources we utilise are derived from the sun's energy.

Electricity

Learners need to experience:

- designing and constructing electrical circuits, and taking measurements from them.

Learners need to know:

- the different types and uses of electricity
- the concept of current, voltage and resistance.

Learners need to be able to:

- design and analyse schematic circuits.

Waves

Learners need to experience:

- a range of experiments that illustrate wave phenomena.

Learners need to know:

- the properties of waves and how they move and transfer energy
- the properties of transverse and longitudinal waves, and the similarities and differences between them.

Learners need to be able to:

- describe waves.

Magnetism

Learners need to experience:

- experimenting with magnetic fields.

Learners need to know:

- that some materials are magnetic and are affected by magnetic fields.

Learners need to be able to:

- identify magnetic fields and know how they interact.

Progression step 4

Forces and motion

Learners need to experience:

- motion in a range of contexts with opportunities to measure, describe and quantify observations
- how forces and motion apply to celestial bodies in space.

Learners need to know:

- the relationship between force, structure and motion.

Learners need to be able to:

- observe the effects of forces on the motion of objects
- analyse the motion of objects and the associated forces.

Energy

Learners need to experience:

- investigating ways energy can be stored and transferred.

Learners need to know:

- the principle of conservation of energy, and the forms of energy in physical systems and ecosystems
- the transfer and transformation of energy
- that most of the energy sources we utilise are derived from the sun's energy.

Learners need to be able to:

- apply the principle of conservation of energy in order to make predictions about a variety of situations.

Electricity

Learners need to experience:

- designing and constructing electrical circuits, and taking measurements from them.

Learners need to know:

- how static electricity is caused by the transfer of electrons
- the relationship between power, voltage, current, resistance, charge and energy
- the inputs and outputs of logic gates.

Learners need to be able to:

- design and analyse schematic circuits.

Waves

Learners need to experience:

- a range of experiments that illustrate wave phenomena.

Learners need to know:

- the properties of waves and how they move and transfer energy
- the properties of transverse and longitudinal waves, and the similarities and differences between them.

Learners need to be able to:

- describe waves quantitively.

Magnetism

Learners need to experience:

- experimenting with magnetic fields.

Learners need to know:

- some materials are magnetic and are affected by magnetic fields
- magnetic fields can be caused by electric currents.

Learners need to be able to:

- identify magnetic fields and know how they interact
- apply knowledge of magnets and electric fields to predict their behaviour.

Progression step 5

Forces and motion

Learners need to experience:

- motion in a range of contexts with opportunities to measure, describe and quantify observations
- how forces and motion apply to celestial bodies in space.

Learners need to know:

- the relationship between force, structure and motion.

Learners need to be able to:

- observe the effects of forces on the motion of objects
- analyse the motion of objects and the associated forces.

Energy

Learners need to experience:

- investigating ways energy can be stored and transferred
- the role of energy and forces in thermodynamics and gas laws.

Learners need to know:

- the principle of conservation of energy and the forms of energy in physical systems and ecosystems
- the transfer and transformation of energy
- most of the energy sources we utilise are derived from the sun's energy.

Learners need to be able to:

- apply the principle of conservation of energy in order to make predictions about a variety of situations.

Electricity

Learners need to experience:

- designing and constructing electrical circuits, and taking measurements from them.

Learners need to know:

- how static electricity can be used and mitigated
- the differences between power, voltage, current, resistance, charge and energy
- how logic gates can be applied to solve simple logic problems.

Learners need to be able to:

- design and analyse schematic circuits.

Waves

Learners need to experience:

- wave phenomena practically and experimentally.

Learners need to know:

- the properties of waves and how they move and transfer energy
- the properties of transverse and longitudinal waves, and the similarities and differences between them
- how information is carried by waves in both digital and analogue form.

Learners need to be able to:

- describe waves, including describing the properties of a wave mathematically.

Magnetism

Learners need to experience:

- magnetic fields experimentally.

Learners need to know:

- some materials are magnetic and are affected by magnetic fields
- that magnetic fields can be caused by electric currents.

Learners need to be able to:

- identify magnetic fields and know how they interact
- apply knowledge of magnets and electric fields to predict their behaviour.

WHAT MATTERS IN
SCIENCE AND TECHNOLOGY

Computation applies algorithms to data in order to solve real-world problems.

In Science and Technology, we recognise that computational processes have changed the way people interact with one another and their environment, as well as how humans organise their work, their communities and their lives. Society, in turn, has influenced the development of computation as people's needs for processing information have changed. Through these computational processes the world has been enriched and technological development has accelerated, and seems set to continue doing so. In order to use and create these technologies to their full potential, learners need to know how they work. Developing creative algorithmic and computational approaches can solve challenging real-world problems. However, we must be conscious that there are limits to what computers can achieve. Understanding that there are also wider legal, social and ethical consequences of how technology is used enables learners to make informed decisions about the application of computational technologies.

Learning

Principles of progression

Principles of progression are the basis on which the achievement outcomes have been developed and should guide the progression of learning within the area of learning and experience.

- Learners' thinking develops from concrete to abstract and from observable to unobservable.
- Learners develop from qualitative description to quantification.
- Learners move from describing ideas to being able to explain ideas.
- Learners begin by recognising single factors and progress to consider multiple factors.
- Learners develop simple skills through adopting and adapting, moving towards the creation of original content.

Progression step 1

Achievement outcomes

Algorithms

I can identify, create and follow sequences and patterns in everyday activities.

I can follow simple sets of instructions.

I can identify errors in simple sets of instructions.

Computational systems

I can experiment with and identify uses of a range of computing technology in the world around me.

Progression step 2

Achievement outcomes

Algorithms

I can use computational thinking techniques, using unplugged or offline activities, e.g. abstraction, decomposition and pattern recognition.

I can give simple sets of instructions.

Data

I can explain the importance of accurate and reliable data to ensure a desired outcome.

I can sort and search data using a single criterion and present it in a variety of different formats within familiar contexts.

Computational systems

I can follow instructions to build, test and control a physical device.

Cyber security

I can use credentials securely to keep information safe.

Progression step 3

Achievement outcomes

Algorithms

I can decompose a problem into smaller specific tasks.

I can build simple programs to carry out a given task by using an appropriate programming language.

Data

I can manipulate and interrogate data to help make informed decisions and predictions.

I can use multiple criteria in my data interrogation.

Computational systems

I can define, develop, test and debug systems that have software and hardware that interact with each other.

Cyber security

I can describe how computers communicate, and share data and resources securely.

Progression step 4

Achievement outcomes

Algorithms

I can use computational-thinking techniques to modify designs and programs, then evaluate their effectiveness.

Data

I can use appropriate programming languages to manipulate and interrogate data in order to help me make informed decisions and predictions.

Computational systems

I can apply logical and critical thinking when modifying and testing systems.

Cyber security

I can use, describe and evaluate increasingly sophisticated methods of securing data and systems.

Progression step 5

Achievement outcomes

Algorithms

I can use a range of computational-thinking techniques to deal with open-ended problems.

Data

I can evaluate organisations' use of algorithms to manipulate data in legal and ethical contexts.

I can ethically derive information by analysing data sets of varying sizes.

Computational systems

I can show resilience when developing software and systems that solve open-ended problems.

Cyber security

I can identify, defend and prevent forms of cyber attacks.

Planning for learning

Links within this area of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across the Science and Technology Area of Learning and Experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

- Using scientific approaches to interrogate and analyse data.
- Design, engineering and the sciences providing rich contexts to explore the implications of Science and Technology, including the ethical and societal issues of machine learning.
- The role of digital tools in developing and communicating design, engineering and scientific solutions.
- How digital systems inform and contextualise the development of a systems-thinking approach.

Links with other areas of learning and experience

This section suggests where learning can be enriched through drawing links between other what matters statements across all the areas of learning and experience. It also suggests where different elements of learning could be considered together in order to support more holistic learning.

Expressive Arts

- The use of digital technology when creating and designing.

Health and Well-being

- The impacts and addictive behaviours in respect of technology and in an online context.
- Online safety and decision-making, including the implications on oneself and others.

Humanities

- Inquiry using sources and evidence.
- The societal impact of digital technology.

Languages, Literacy and Communication

- The role of digital tools in contemporary communication.
- Access to factual texts.

Mathematics and Numeracy

- The recognition of patterns, syllables, trends and sequences.
- Number, data, classification and statistics.
- The presentation of findings from inquiry.
- The consideration of variables and the development of reasoning.

Experiences, knowledge and skills

Progression step 1

Algorithms

Learners need to experience:

- following simple sets of instructions
- identifying errors in simple sets of instructions
- controlling programmable devices during their play.

Computational systems

Learners need to experience:

- using a range of technology during their play.

Learners need to be able to:

- use available digital equipment appropriately.

Cybersecurity

Learners need to experience:

- keeping digital information safe and private.

Progression step 2

Algorithms

Learners need to experience:

- predicting the outcome of instructions
- coding a simple programme to create and refine a set of instructions through unplugged or offline activities
- following an increasingly complex set of instructions.

Data

Learners need to experience:

- inputting data into a computer system
- unplugged or offline activities that investigate the importance of accurate and reliable data.

Learners need to know:

- that data can be stored in different formats, e.g. databases, spreadsheets and tally charts.

Learners need to be able to:

- collect and make sense of data gathered through hands-on investigations
- analyse data by sorting and searching using a single criterion
- communicate data in a range of formats.

Computational systems

Learners need to experience:

- using a range of technology during their play
- programming simple components (such as motors, sensors and push-buttons), using a digital device to build and make something happen.

Learners need to be able to:

- select and use available digital equipment appropriately.

Cybersecurity

Learners need to experience:

- entering credentials.

Learners need to know:

- that they need to keep some information safe.

Progression step 3

Algorithms

Learners need to experience:

- creating digital solutions, using both physical and virtual systems
- using machine-learning applications.

Learners need to be able to:

- solve problems by applying the computational techniques of decomposition, abstraction, algorithmic thinking, programming and simulation, through the use of block and text-based languages
- predict the outcome of sequences of instructions
- detect and correct mistakes in their own and others' algorithms.

Data

Learners need to know:

- that individuals, commercial companies and government agencies use data within algorithms
- that data can be stored in different formats
- a range of appropriate methods to validate and verify data.

Learners need to be able to:

- make informed decisions by using scientific methods to interrogate and analyse data
- collect then input data into a computer system
- interrogate data by using multiple criteria and sorts
- communicate data in a range of appropriate formats
- apply a range of appropriate methods to validate and verify data.

Computational systems

Learners need to experience:

- experimenting with a range of devices that, when appropriate, use input sensors and physical outputs to create a solution.

Learners need to know:

- that the virtual and physical worlds connect
- that computer systems can be used to solve real-world problems
- that real-world data is represented inside a computer
- that sensors capture data about the real world
- that computers take input data, store it, process it, and output it as information.

Learners need to be able to:

- input data in a variety of ways, process it into information and present it in an appropriate format.

Cybersecurity

Learners need to experience:

- simulating the communication process of a computer network and be able to describe vulnerabilities.

Learners need to know:

- about security methods that defend against personal, political and commercial cyber attacks
- about Wales' contributions to the continual development and use of computational technologies, and their influence on Welsh affairs.

Learners need to be able to:

- base decisions about the use of computation on ethical and legal considerations
- manage computer system credentials responsibly
- describe the key parts of consent ownership and accountability of data
- describe the vulnerabilities of a network.

Progression step 4

Algorithms

Learners need to experience:

- creating digital solutions, using both physical and virtual systems
- constructing and critiquing
- using machine-learning applications.

Learners need to be able to:

- solve problems by applying the computational techniques of decomposition, abstraction, algorithmic thinking, programming and simulation, through the use of block and text-based languages
- develop applications by training a machine-learning engine
- apply sophisticated validation methods to maintain the robustness and integrity of their systems
- predict the outcome of sequences of instructions
- detect and correct mistakes in their own and others' algorithms.

Data

Learners need to experience:

- using different data types in appropriate software applications
- analysing and evaluating the appropriate use of data types and structures in programs.

Learners need to know:

- how individuals, commercial companies and government agencies use data within algorithms
- that computer systems depend on reliable data and that there are methods that can be used to ensure data integrity
- that data can be collected and used in ethical and unethical ways
- that data can be stored in different formats
- a range of appropriate methods to validate and verify data.

Learners need to be able to:

- make informed decisions by using scientific methods to interrogate and analyse data
- collect then input data into a computer system
- interrogate data by using multiple criteria and sorts
- communicate data in a range of appropriate formats
- use program code to extract *(echdynnu)* and interrogate data
- apply a range of appropriate methods to validate and verify data.

Computational systems

Learners need to experience:

- using a range of components
- applying code to control components
- creating and using a testing plan.

Learners need to know:

- how the virtual and physical worlds connect
- how computer systems solve real-world problems
- how real-world data is represented inside a computer
- how sensors capture data about the real world
- how computers take input data, store it, process it, and output it as information.

Learners need to be able to:

- select and use a range of components to create a system that fulfils a brief
- develop, refine and evaluate a system that fulfils a brief, and do so collaboratively and independently
- explain and justify their design decisions.

Cybersecurity

Learners need to experience:

- detecting and mitigating cyber attacks
- simulating the communication process of a computer network.

Learners need to know:

- about security methods in order to defend against personal, political and commercial cyber attacks
- about Wales' contributions to the continual development and use of computational technologies, and their influence on Welsh affairs.

Learners need to be able to:

- base decisions about the use of computation on ethical and legal considerations
- manage computer system credentials responsibly
- describe the key parts of consent ownership and accountability of data
- describe the vulnerabilities of systems and networks.

Progression step 5

Algorithms

Learners need to experience:

- creating digital solutions using both physical and virtual systems
- constructing and critiquing
- using machine-learning applications
- opportunities to debate the ethical and societal issues of machine learning.

Learners need to know:

- the ways in which machine learning works.

Learners need to be able to:

- solve problems by applying the computational techniques of decomposition, abstraction, algorithmic thinking, programming and simulation, through the use of block and text-based languages
- develop applications by training a machine-learning engine
- apply sophisticated validation methods to maintain the robustness and integrity of their systems
- predict the outcome of sequences of instructions
- detect and correct mistakes in their own and others' algorithms.

Data

Learners need to experience:

- using different data types in appropriate software applications
- analysing and evaluating the appropriate use of data types and structures in programs.

Learners need to know:

- how individuals, commercial companies and government agencies use data within algorithms
- that computer systems depend on reliable data and that there are methods that can be used to ensure data integrity
- that data can be collected and used in ethical and unethical ways
- that data can be stored in different formats
- a range of appropriate methods to validate and verify data.

Learners need to be able to:

- make informed decisions by using scientific methods to interrogate and analyse data
- collect then input data into a computer system
- interrogate data by using multiple criteria and sorts
- communicate data in a range of appropriate formats

- use program code to extract *(echdynnu)* and interrogate data
- apply a range of appropriate methods to validate and verify data.

Computational systems

Learners need to experience:

- using a range of interacting components
- applying code to control components
- creating and using a testing plan
- designing a brief from an identified need
- identifying the computational requirements and restrictions of the need
- different roles within a project team.

Learners need to know:

- how the virtual and physical worlds interact
- how computer systems solve real-world problems
- how real-world data is represented inside a computer
- how sensors capture data about the real world
- how computers take input data, store it, process it, and output it as information
- the computational constraints of projects
- the constraints of the skills within project teams.

Learners need to be able to:

- work as a team to use computation to solve a problem within their community.

Cybersecurity

Learners need to experience:

- detecting and mitigating cyber attacks
- simulating the communication process of a computer network and be able to describe vulnerabilities.

Learners need to know:

- about security methods in order to defend against personal, political and commercial cyber attacks
- about Wales' contributions to the continual development and use of computational technologies, and their influence on Welsh affairs.

Learners need to be able to:

- base decisions on ethical and legal considerations in relation to the use of computation
- defend against online attacks
- manage computer system credentials responsibly

- describe the key parts of consent ownership and accountability of data
- describe the vulnerabilities of a network
- appreciate the ethical considerations of cyber attacks.

GLOSSARY

Word/phrase	Definition
Algorithm	A process or set of instructions to be followed in calculations or other problem-solving operations, especially by a computer.
Circular design	A concept where products are designed so they save or reuse resources; they can easily be repaired and used for longer periods of time.
Credentials	For example: passwords, PINs, fingerprints.
Design thinking *(Meddylfryd dylunio)*	A design methodology that provides a solution-based approach to solving problems.
Design tools and strategies	For example: considering existing products, deconstruction, their improvement and testing.
Ecosystem	A biological community of interacting organisms and their physical environment.
Energy stores	The way energy is stored in different ways, as it cannot be created or destroyed.
Energy transfer	The conversion of one form of energy into another, or movement from one place to another, e.g. energy is transferred from a hot object to a cool one by conduction or radiation.
Forces	A push or pull upon an object resulting from its interaction with another object.
Germs	Micro-organisms, especially those which cause disease.
Habitat	The natural environment of an animal, plant, or other organism.
High-fidelity and low-fidelity prototyping	Low-fidelity prototyping is a quick way to translate high-level design concepts into tangible and testable artefacts in order to test prototype functionality. High-fidelity prototyping is highly functional, close to the final product.
Life cycle	The continuous sequence of changes an organism undergoes from the start of life through to the end of life.
Longitudinal waves	Waves in which the vibration are in the same plane as the direction of travel, e.g. sound waves

Word/phrase	Definition
Mathematical model	A description of using mathematical concepts and language. It may help to explain a system, to study the effects of different components, and to make predictions about behaviour
Matter	Physical substance that occupies space and possesses rest mass, especially as distinct from energy.
Models	A representation of a system, made of concepts used to help people know, understand, or simulate what the model represents.
Physical device	Digital solutions, e.g. laptops, tablets, phones.
Physical outputs	Otherwise known as actuators – a component of a machine that is responsible for moving and controlling a mechanism or system.
Planned obsolescence	Planning or designing a product with an artificially limited life so it becomes unfashionable or non-functional after a certain period of time.
Reaction	Chemical process in which substances act mutually on each other and are changed into different substances, or one substance changes into other substances.
Sampling techniques	Such as quadrat, transect, capture, recapture to estimate the number of organisms within a sample area.
Schematic circuits	A representation of the elements of a system, using abstract, graphic symbols rather than realistic pictures.
Sets of instructions	Algorithm.
Systems thinking *(Meddylfryd systemau)*	Systems thinking is a holistic approach that focuses on the way that a system's constituent parts interrelate.
Transverse waves	Waves in which the vibrations are at right angles to the direction of wave travel, e.g. light waves.
Variety of materials	Which can also include a range of tools to represent a current.
Visual literacy	The ability to communicate ideas visually, e.g. through drawing, sketching, rendering, computer-aided design.
Wave phenomena	For example: light, dark, shadows, reflections, vibrations and sound.

Mae'r ddogfen yma hefyd ar gael yn Gymraeg. This document is also available in Welsh.